A Model Study of T=0 and T=1 Pairing in a Single j-shell

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Recent advances in experimental techniques and new possibilities that are becoming available with the use of radioactive beams, are driving a renaissance of nuclear structure studies along the N=Z line. A subject of particular interest in these nuclei is the study of isoscalar (T=0) and isovector (T=1) pairing correlations. A wealth of experimental data has been accumulated supporting the important role of *nn* and *pp* “Cooper pairs”. following the initial suggestion by Bohr, Mottelson and Pines [1] of a pairing mechanism in the nucleus, analogous to that observed in superconductors, In contrast to this well established phenomenon we are still searching for a clear signature of the formation of correlated T=0 *np* pairs.

A single *l*-shell model [3] has been considered in the literature to describe the large spatial overlap of the nucleon wave functions in an $L=0$ state. However, the spin-orbit splitting v_{ls} will increase the energy needed to form the $S=1$ partners and will then favor a $J=1$ configuration. Therefore, it seems interesting to consider the more realistic case of a single *j*-shell that incorporates the more appropriate *jj* coupling scheme. We used the code OXBASH [2] introducing an effective two-body force of the form $V = xV_{J=0}^{T=1} + (1-x)V_{J=1}^{T=0}$ to model the mixture of the two types of interactions by the value of x. Although both models show similar behavior of the low lying T=0 and T=1 states as a function of the mixture, one can readily see that the spin-orbit interaction reduces the binding energy for the isoscalar limit. This is due to the fact that an important part of the $L=0$ pairing correlations in this channel is removed because the spin-orbit partner is pushed to higher energies.

An intriguing phenomenon is shown in Fig. 1, where the evolution of the two lowest states in the 4 particle system as a function of the spin-orbit splitting is calculated for a pure isoscalar force. The ground state changes from the 0^+ to a state with spin 2^+. Moreover, the ground state for N=6 is a 3^+ and not 1^+, and is a 4^+ for the N=8 system. Considering that for 2 particles interacting with an appreciable amount of isoscalar pairing ($x < 0.5$) the force favors a ``deuteron-like" pair of spin 1^+, it appears that the ground state of the many particle system prefers the aligned configuration of these pairs, i.e. that with spin J=N/2. We do no have at the moment a simple explanation for this effect.

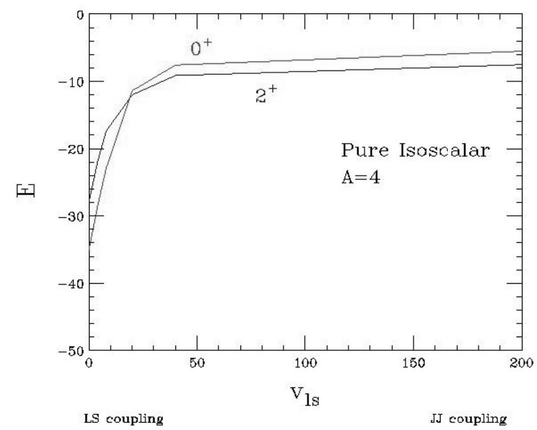

Fig. 1. Evolution of the lowest T=0 states in a system of 4 particles as a function of the spin-orbit splitting.

Footnotes and References

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